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ABSTRACT

This learning module, one in a series of 20 related training modules for apprentice stationary engineers, deals with lubrication. Addressed in the individual instructional packages included in the module are the various types of lubricants, lubricant standards, and criteria for selecting lubricants. Each instructional package in the module contains some or all of the following: a lesson goal, performance indicators, a study guide, a vocabulary list, an introduction, instructional text, an assignment, a job sheet, a self-assessment activity, a post-assessment instrument, answers to the post-assessment instrument, and a list of recommended supplementary references. (MN)

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ED254705

APPRENTICESHIP

STATIONARY ENGINEERS

RELATED TRAINING MODULES

11.1 - 11.2 LUBRICATION

CE 040981

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APPRENTICESHIP

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STATIONARY ENGINEER
SUPPLEMENTARY REFERENCE DIRECTORY

Note: All reference packets are numbered on the upper right-hand corner of the respective cover page.

Supplementary Packet #	Description	Related Training Module
12.1	Correspondence Course, Lecture 1, Sec. 2, Steam Generators, Types of Boilers I, S.A.I.T., Calgary, Alberta, Canada	12.1 Boilers, Fire Tube Type
12.2	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Types of Boilers II, S.A.I.T., Calgary, Alberta, Canada	12.2 Boilers, Water Tube Type
12.3	Correspondence Course, Lecture 2, Sec. 2, Steam Generators, Boiler Construction & Erection, S.A.I.T., Calgary, Alberta, Canada	12.3 Boilers, Construction
12.4	Correspondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fittings II, S.A.I.T., Calgary, Alberta, Canada	12.4 Boilers, Fittings
12.4	Corresondence Course, Lecture 4, Sec. 2, Steam Generators, Boiler Fitting I, S.A.I.T., Calgary, Alberta, Canada	12.4 Boilers, Fittings
12.5	Correspondence Course, Lecture 10, Sec. 2, Steam Generation, Boiler Operation, Maintenance, Inspection, S.A.I.T., Calgary, Alberta, Canada	12.5 Boilers, Operation
12.7	Correspondence Course, Lecture 3, Sec. 2, Steam Generation, Boiler Details, S.A.I.T., Calgary, Alberta, Canada	12.7 Boilers Heat Recovery Systems
12.8	Refer to reference packet 14.3/12.8	
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13.6		13.6 Monitoring & Troubleshooting
13.7		13.7 Maintenance
13.3	Correspondence Course, Lecture 6, Sec. 3, Steam Generators, Pumps, S.A.I.T., Calgary, Alberta, Canada	13.3 Construction
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14.4	Correspondence Course, Lecture 11, Section 2, Steam Generators, Piping II, S.A.I.T., Calgary, Alberta, Canada	14.4 Steam, Purification
15.1	Correspondence Course, Lecture 1, Sec. 4, Prime Movers & Auxiliaries, Steam Turbines, S.A.I.T., Calgary, Alberta, Canada	15.1 Steam Turbines, Types
15.2	Correspondence Course, Lecture 4, Sec. 3, Prime Movers, Steam Turbines I, S.A.I.T., Calgary, Alberta, Canada	15.2 Steam Turbines, Components
15.3	Correspondence Course, Lecture 2, Sec. 4, Prime Movers & Auxiliaries, Steam Turbine Auxiliaries, S.A.I.T., Calgary, Alberta, Canada	15.3 Steam Turbines, Auxiliaries
15.4	Correspondence Course, Lecture 6, Sec. 3, Prime Movers, Steam Turbine Operation & Maintenance, S.A.I.T., Calgary, Alberta, Canada	15.4 Steam Turbines, Operation & Maintenance
15.5	Correspondence Course, Lecture 8, Sec. 3, Prime Movers, Gas Turbines, S.A.I.T., Calgary, Alberta, Canada	15.5 Gas Turbines
16.2	Boilers Fired with Wood and Bark Residues, D.D. Junge, F.R.L., O.S.U. 1975	16.2 Combustion Types of Fuel
16.2	Correspondence Course, Lecture 5, Sec. 2, Steam Generators, Fuel Combustion, S.A.I.T., Calgary, Alberta, Canada	16.2 Combustion Types of Fuel
16.3	Correspondence Course, Lecture 5, Sec. 2, Plant Services, Fuel & Combustion, S.A.I.T., Calgary, Alberta, Canada	16.3 Combustion, Air & Fuel Gases
17.1	Correspondence Course, Lecture 12, Sec. 3, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	17.1 Feed Water, Types & Operation
17.2	Correspondence Course, Lecture 12, Sec. 2, Steam Generation, Water Treatment, S.A.I.T., Calgary, Alberta, Canada	17.2 Feed Water, Water Treatments

Supplementary Packet #	Description	Related Training Module
17.3	Correspondence Course, Lecture 7, Sec. 2, Steam Generators, Boiler Feed Water Treatment, S.A.I.T., Calgary, Alberta, Canada	17.3 Feed Water, Testing
18.1	Correspondence Course, Lecture 2, Sec. 5, Electricity, Direct Current Machines, S.A.I.T., Calgary, Alberta, Canada	18.1 Generators, Types & Construction
18.1 18.2	Correspondence Course, Lecture 4, Sec. 5, Electricity, Alternating Current Generators, S.A.I.T., Calgary, Alberta, Canada	18.1 Generators, Types & Construction 18.2 Generators, Operation
19.1	Corrspondence Course, Lecture 5, Sec. 4, Prime Movers & Auxiliaries, Air Compressor I, S.A.I.T., Calgary, Alberta, Canada	19.1 Air Compressors, Types
19.1 19.2	Correspondence Course, Lecture 6, Sec 4, Prime Movers & Auxiliaries, Air Compressors II, S.A.I.T., Calgary, Alberta, Canada	19.1 Air Compressors, Types 19.2 Air Compressors, Operation & Maintenance
20.1	Basic Electronics, Power Transformers, EL-BE-51	20.1 Transformers
21.1	Correspondence Course, Lecture 7, Sec. 5, Electricity, Switchgear & Circuit, Protective Equipment, S.A.I.T., Calgary, Alberta, Canada	21.1 Circuit Protection
22.1	Correspondence Course, Lecture 10, Sec. 3, Prime Movers, Power Plant Erection & Installation, S.A.I.T., Calgary, Alberta, Canada	22.1 Installation Foundations

RECOMMENDATIONS FOR USING TRAINING MODULES

The following pages list modules and their corresponding numbers for this particular apprenticeship trade. As related training classroom hours vary for different reasons throughout the state, we recommend that the individual apprenticeship committees divide the total packets to fit their individual class schedules.

There are over 130 modules available. Apprentices can complete the whole set by the end of their indentured apprenticeships. Some apprentices may already have knowledge and skills that are covered in particular modules. In those cases, perhaps credit could be granted for those subjects, allowing apprentcies to advance to the remaining modules.

We suggest the the apprenticeship instructors assign the modules in numerical order to make this learning tool most effective.

SUPPLEMENTARY INFORMATION

ON CASSETTE TAPES

Tape 1: Fire Tube Boilers - Water Tube Boilers and Boiler Manholes and Safety Precautions

Tape 2: Boiler Fittings, Valves, Injectors, Pumps and Steam Traps

Tape 3: Combustion, Boiler Care and Heat Transfer and Feed Water Types

Tape 4: Boiler Safety and Steam Turbines

NOTE: The above cassette tapes are intended as additional reference material for the respective modules, as indicated, and not designated as a required assignment.

11.1

LUBRICATION -- INTRODUCTION

Goal:

The apprentice will be able to discuss the basic concepts of petroleum products.

Performance Indicators:

1. Describe source of petroleum products.
2. Describe products of crude oil.
3. Identify organizations that set standards for lubricants.
4. Describe requirements of engine oils.

108-A INTRODUCTION TO LUBRICATION

This learning package introduces the subject of lubrication as it applies to areas covered by Industrial Mechanics. Lubrication materials described in this series are petroleum based.

Upon successful completion of this learning package, the student will by able to:

1. Describe the source of petroleum products.

2. Identify eight products derived from crude oil.

3. List four lubricant standard-setting organizations.

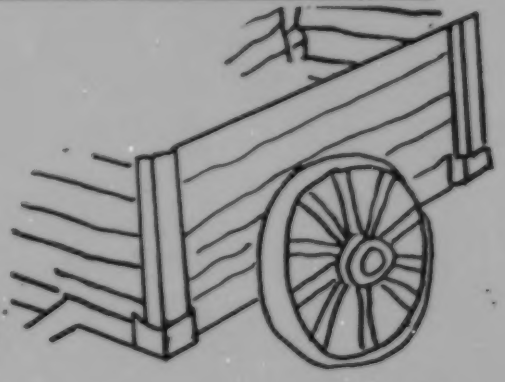
4. List six requirements for modern engine oils.

LEARNING ACTIVITIES

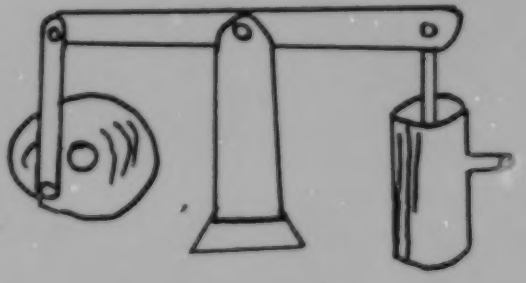
ACTIVITIES	PURPOSE
Read: Information Sheet	Basic background information to this lesson series is provided in this information sheet.
Read: Crouse, Automotive Mechanics McGraw-Hill Book Co. chapter on Engine Lurbication Systems	
Read: John Deere, Fundamentals of Service Manual, chapter on Lubrication	To broaden the appreciation for lubricants and their usage, as described by other authors.
Read: American Association for Agriculture Engineering and Vocational Agriculture, Tractor Fuels and Lubricants, Selection and Storage, chapter on Selecting Lubricants for Tractors	
Read: Selected materials on Lubricants from various oil companies	

LUBRICATION INTRODUCTION

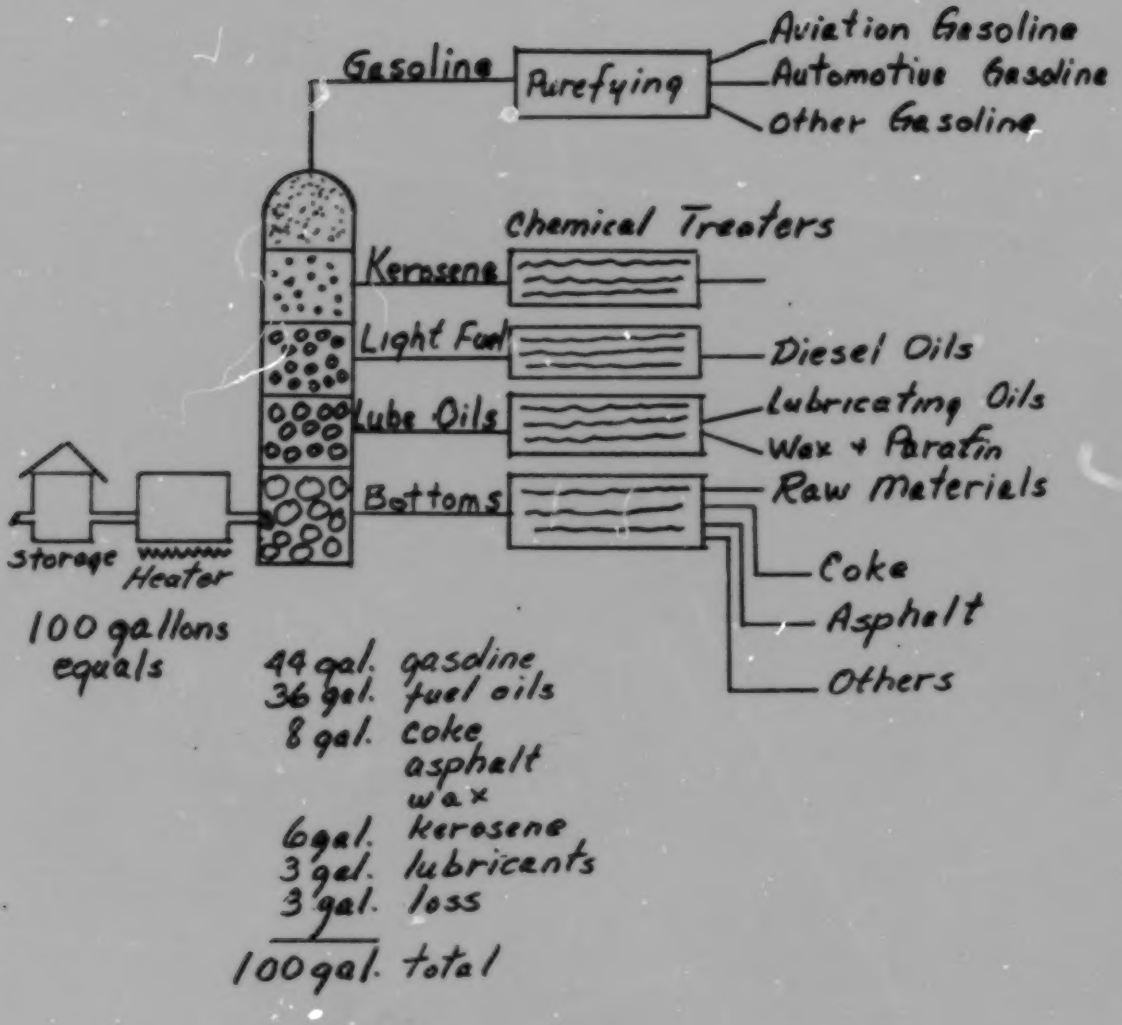
The era of animal drawn vehicles required lubrication. Greases used were in a simple form that reduced friction by providing a grease film to keep the contracting surfaces from rubbing on one another.



Crude oil is pumped from the ground. In its raw state, crude is a mixture of many materials. Natural gas may exist at the well and it may be siphoned off in its raw state to be used for heating homes and industry. The crude must be processed to separate it into commercially valuable products.



The schematic rough sketch shows some of the basic parts of a crude cracking plant and the processes for drawing off various products from the crude oil.



As you can see, the products range from natural gas to asphalt.

Special oils have been developed for new functions that have beeen engineered into modern machines. Automatic transmissions and hydraulic components, for example, may require a different oil. (Some may have differences between equipment manufacturers. Gear oils and greases are developed for different types of uses. Currently, all of these products may be produced from crude oil. There are new lubricants available today but for the most part, lubricating products are from a petroleum (hydro-carbon) base.

There are many commercial companies in this business. Each has his own claims as to why his products are the best. Because each producer had his own standards, a great deal of confusion resulted. Leading representatives of the industry organized into the American Petroleum Institute (API) to establish industry

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standards for their products. Other concerned groups such as: The Society of Automotive Engineers (SAE), the federal government (Mil Spec), individual equipment manufacturers, and the American Society for Testing Materials (ASTM) also set standards. The equipment manufacturers felt that standards were required in order to specify petroleum products for their equipment to prevent premature failure of parts by inadequate lubrication materials. A user of one "premium" product might not get as good a quality of material as could be found in another "premium" product without specific standards.

For the above reasons, most modern fuels, oils, and greases are tested and are advertised to meet one or more of many various standards. A user may then base his selection of fuel or lubrication materials in part on this criteria. However, there are certain additives and refining processes that do not fall under these standards and thus the manufacturers may vary their products within the standards. An example of this may be in the quantity of detergent or other additives in a fuel or an oil product.

Today's mechanical equipment demands much more from the lubricating materials.

Constant research by oil companies to meet the requirements of equipment manufacturers has upgraded the number and quality of lubrication products. For example, early engine oils were developed for primitive engines of low power, speed, and short life. The oil would adequately provide lubrication when the slow-moving parts would splash through the crankcase oil. Today's engine oil is expected to:

- lubricate for heavier loads
- lubricate at high speeds
- lubricate at high temperatures
- provide sealing at the rings
- clean engine parts
- cool the engine
- reduce rust and corrosion
- flow easily at low temperatures
- resist breakdown
- and - yes, reduce friction

A good rule to follow is to select a reputable product from a reliable dealer and use those products. Perhaps comments by your equipment dealer or your own experience will cause you to go to, or stay away from a particular brand of products.

Always remember that whatever products you select must be kept free from dust, dirt and moisture. They must also receive regular maintenance. The material selected should be used as directed by their manufacturer.

SELF-TEST

1. What was the <u>one</u> requirement of lubricants for old slow-moving equipment?

2. List four additional requirements of modern lubricants.

3. ASTM stand for what testing group?

4. These testing societies are important in setting product _____.

5. List the two top volume products obtained from crude oil.

6. Lubricants have been improved with _____.

SELF-TEST ANSWERS:

1. reducing friction
2. clean, cool, reduce friction, reduce rust, high and low temperature operation
3. American Society Testing and Measurements
4. standards
5. gas and fuel oil
6. additives

POST-TEST KEY Package No. 108-A

INTRODUCTION TO LUBRICATION

1. Society of Automotive Engineers.

2. American Society for Testing Materials.

3. American Petroleum Institute

4. Petroleum (hydro-carbon)

5. a. gasoline
   b. fuel oils

POST—TEST

Package Number 108-A

INTRODUCTION TO LUBRICATION

Name _____ Date _____

1. What does S.A.E. stand for?

2. What does A.S.T.M. stand for?

3. What does A.P.I. stand for?

4. Lubricating products are from a _____ base.

5. List the two top volume products obtained from crude oil.

   a.
   b.

11.2

LUBRICANT -- STANDARDS AND SELECTION OF LUBRICANTS

Goal:

The apprentice will be able to describe the characteristics of lubricants and their standards of quality.

Performance Indicators:

1. Describe oil additives.
2. Describe viscosity.
3. Describe effect of temperature on single and multiple viscosity oils.
4. Describe product standards.

108-B OIL STANDARD LUBRICATION AND SELECTION

One type of lubricant is oil. This unit will teach some terminology, characteristics, and quality standards for oil. Emphasis may appear to be on engine oils, yet viscosity control and quality standards are similar in other applications.

Upon successful completion of this learning package, the student will be able to:

1. List four engine oil additives and describe their action.
2. Define viscosity.
3. Explain how single and multiple viscosity oils react to temperature.
4. Identify oils that fit into various categories of service for gasoline and diesel use.
5. Select the correct oil for use in a vehicle based upon manufacturer's information and intended vehicle use.
6. Explain which oils may and may not be mixed in service.
7. Describe six ways that oils may fail in service.

LEARNING ACTIVITIES

ACTIVITIES	PURPOSE
Read: Information Sheet	To add information from other author sources expanding student knowledge in the subject area.
Read: Automotive Mechanics, McGraw-Hill Book Co., Crouse, chapter on Engine Lubrication Systems	
Read: Fundamentals of Service Manual, John Deere, chapter on Lubrication	
Read: American Association for Agriculture Engineering and Vocational Agriculture Tractor Fuels and Lubricants Selection & Storage Introduction to chapter on Selecting Lubricants for Tractors	
Read: Selected materials on lubricants from various oil companies	
Do: Identify oil viscosity and quality from instructor's samples	Hands on experience provides greater impact in understanding the lesson material.
Do: Following the instructions in the Worksheet, change the oil in an automobile, truck, tractor, etc.	

INFORMATION SHEET

TERMINOLOGY

Additives:

Materials added to the oil to provide extra service that the oil would not normally perform itself.

Oxidation and Corrosion Inhibitor:

Acids form in the oil from oxygen in the air, high temperatures and presence of certain metals. These acids will cause rust and corrosion. The inhibitor additive provides a film over bearing surfaces to keep the acids away.

Detergents:

Another oil additive acts as a soap to keep the dirt and sludge particles suspended and floating in the oil. This permits them to be removed when the oil is drained.

Anti-Foam agent:

This additive lowers the amount of foam in the oil to permit the oil to lubricate properly.

Pour-point depressant:

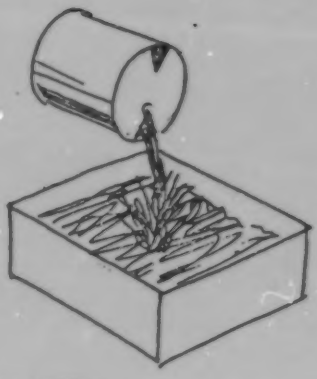
An additive to permit the oil to pour at a lower temperature.

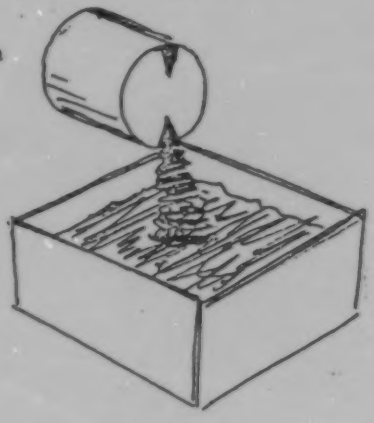
VISCOSITY

The SAE, in cooperation with the petroleu industry, developed the early oil viscosi scales in 1926. Viscosity of an oil has nothing to do with the quality of the oil. The viscosity number identifies how readily an oil flows (fluidity). The higher the number, the thicker the oil and the more slowly it flows.

If a viscosity number is followed by a W (such as 10W or 20W), the oil has been adapted for winter use. It will not exceed the designated viscosity at 0°F. This control of viscosity assures low temperature, thin oil to help the engine to turn more easily and assists winter starting.

Heat affects oil viscosity. Cold temperatures tend to thicken the oils and high temperatures tend to thin the oil. If an engine that has had a great deal of wear, using 10W oil, has to make hot hard runs, the oil may be thinned by the heat to a point where it will no longer provide enough body to keep contacting surfaces separated. The results of this thinning would be a damaged engine. On the other hand, if the same engine were to use #30 weight oil, the engine would perform well. However, starting the engine with #30 in a cold climate may be very difficult as the oil would thicken, causing the engine to be hard to turn and the battery does not function as well when cold.





This problem of heat effect on oil viscosity has been partially solved by the use of the milti-viscosity oils which have come on the market in recent years. A 10W - 30 oil will perform like a 10W oil when cold but will not thin out to less than a #30 when hot. It may be easy to remember that the left or lower number reflects the viscosity at 0°F and the right or higher number reflects the viscosity of the oil when hot (210F). Multigrade oils have been made possible by the use of an additive called the viscosity index improver. Heat affects this additive, causing it to react with the oil molecules to thicken the oil.

NOTE: During hot weather (constantly above 32°), where there is no trouble starting the engine, there is no lubricating advantage in using a multi-grade oil. In fact, in continous, heavy duty, severe, high temperature use, such as experienced by fleet owners, the additive may break down, causing oil consumption to increase and, in some engines, greater deposits may build up than with single viscosity oils.

PRODUCT STANDARDS

Several organizations have been developing standards for the petroleum industry. The organizations are usually identified by their abbreviations or names as follows:

SAE - Society of Automotive Engineers

API - American Petroleum Institute

ASTM - American Society for Testing Materials

Mil Spec - Military specifications which have been derived by the Army, Navy, and Air Force are used as standards for government requirements.

Ford, GM, Chrysler, Caterpiller, etc.

equipment manufacturers that have set specific standards for their products.

Standards have been tightened as the machines and lubricants have improved over the years.

API standards attempt to classify oils by quality. This will permit matching oil to fuel and service requirements of equipment.

Original API classes were regular, premium, and heavy duty. Later, as engines improved, a difference in oils was required between gasoline and diesel engines.

CERTIFIED BY CATERPILLER AS AN APPROVED SERIES 3 LUBRICANT
EXCEEDS MIL-L-45199A
AND MIL-L-2104B AND SUPPLEMENT 1
EXCEEDS CAR MAKERS 'MS
ENGIN TESTS (CHRYSLER, AMERICAN
FORD M2C101B, GM6041M, GM6042M
MEETS ALL NEW CAR
WARRANTEE REQUIREMENTS
FOR API SERVICES MM, MS, DG, DM, DS
Y Y Y

In a 1970 joint effort of the SAE, the API and the ASTM organization, a new classification system to define quality and set specifications for oil has been developed. A brief description is shown in chart #2.

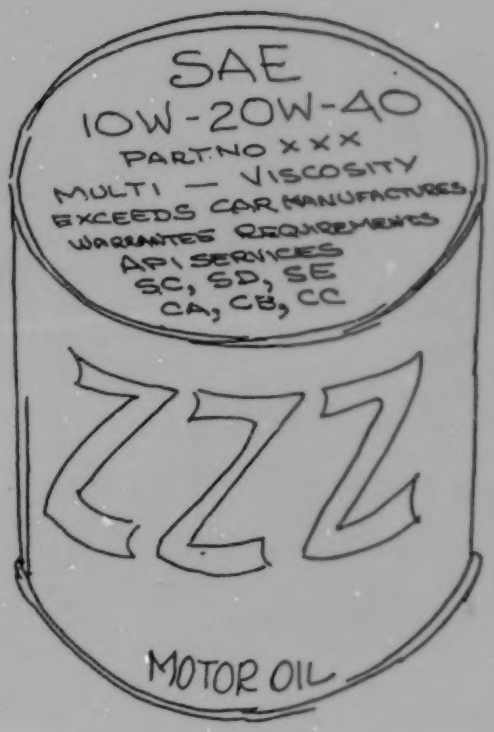
As noted, chart #1 designations are now obsolete. However, some oils with those markings will be available for a long time and a user should understand where these may be used.

Chart #3 provides a cross-reference to the obsolete rating system. For details, check your reference library or oil company literature.

Even in hot weather an engine must be brought up to temperature. Operating at less than normal temperature is a factor in severe service.

Car manufacturer's warranties must assume the user will be operating his vehicle under the most servere conditions. Therefore, manufacturers specify oils that will withstand heavy duty operation.

There are many engine oil problems that can cause unnecessary damage if not understood. Be sure to understand the requirements of your equipment before selecting its engine oils.



SELECTION OF ENGINE OIL

Oil selection is based upon both the viscosity and the quality of the oil. These are determined by the weather (or temperature variations and the use (heavy duty, light duty) to which the equipment will be subjected.

VISCOSITY

Always follow the directions in the operator's manual. An expert from one tractor manufacturer's manual reads as follows: "Depending on the expected prevailing temperature during the fill period use the following weight oil in the engine crankcase.

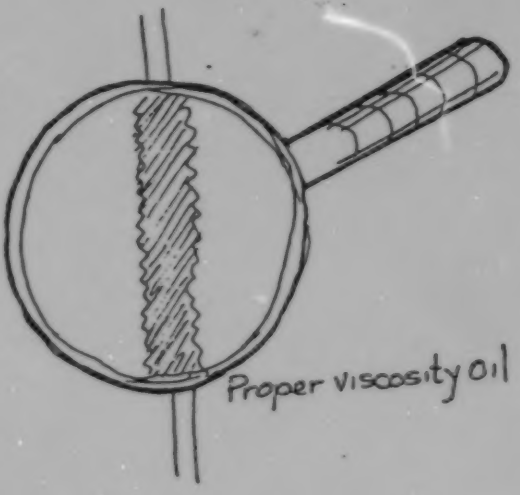
Temperature	Single Viscosity Grade	Multi-Viscosity Grade
Above 90°F	SAE 30	SAE 20W - 40
32°F - 90°F	SAE 20W	SAE 10W - 30
-10°F - -32°F	SAE 10W	SAE 10W - 30
Below -10°F	SAE 5W	SAE 5W - 20

If you are operating your equipment in cold or extremely variable temperatures, multi-viscosity oils may be the best answer in viscosity selection.

In single viscosity oils, do not use a grade that is lighter than recommended. It may be forced out of its bearing surfaces after the engine has warmed and is under load. Too light an oil may permit metal-to-metal contact which leads to rapid wear.

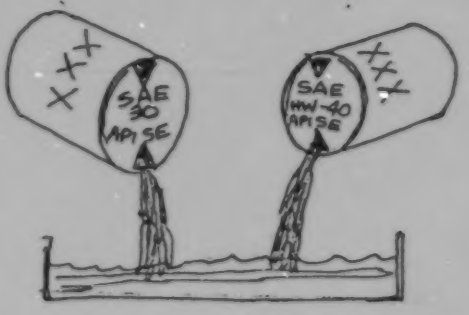
Also, do not use a grade heavier than recommended. This oil will cause undue starting load and may not lubricate critical areas until after the engine warmth has tinned the oil. This condition can also lead to rapid wear.

A manufacturer's operators guide does not apply to other equipment made by the same manufacturer unless it says it does. Differing models of equipment may have different lubrication characteristics Always check with your operator's guide in oil selection.



OIL QUALITY

There is no organization forcing oil companies to test their products to assure they meet the specifications. Major oil companies have their reputation at stake and try to exceed the specifications as identified on their products. Many will state that certain of their products have passed the testing of a reputable testing corportation (eg; ASTM or others). It is always better to select an oil from a reputable oil company if you are unsure of the quality. Keep in mind that new oils meeting newer, more stringent criteria (for example, SE quality for 1972 automotive warrantee) will meet or exceed previous criteria. Do not use MS oil in 1972 and later automobiles unless there is evidence to prove it meets the SE criteria also. Use of these oils may damage the engine and invalidate your warranty.



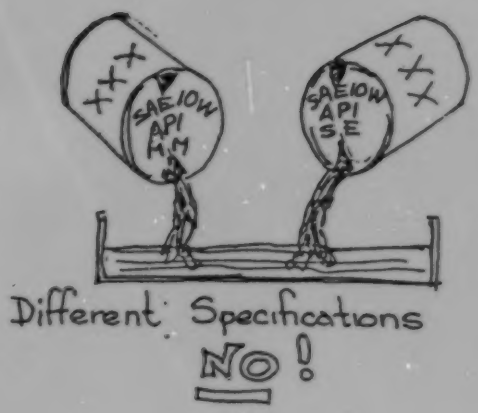
Same brand different Viscosities

OK

Generally speaking, top grade oils from reputable firms do not need to have extra additives as the oils themselves are heavily fortified by the manufacturer.

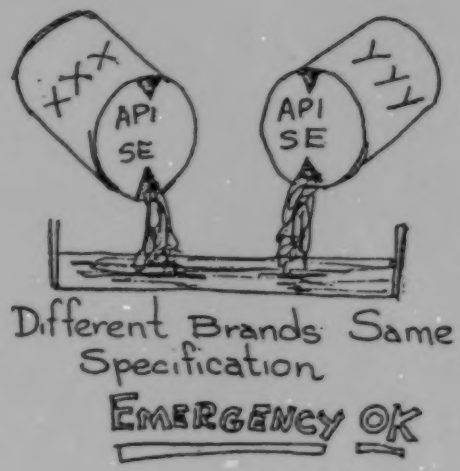
CAUTION: Never mix oils of different specifications. It is possible to mix oils of the same quality specifications but different viscosity indexes. In an emergency, it is permissible to add oil of the same specification but from a different manufacturer. It is usually better to use a different oil than to run low on lubrication.

NOTE: When selecting an oil for an older car, be aware of the previous oil in use. If a mineral (non-detergent) oil has been used, changing to detergent oil may loosen the build-up of old sludge in the engine. Loose sludge may clog oil lines, causing some bearings to run dry and fail.



CONTAMINATION

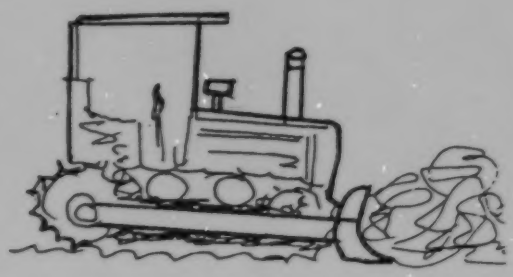
The largest cause for lubrication failure is contamination of the engine oil. No matter what grade oil is used, contamination can reduce engine life more than any other single factor. Contamination is caused by normal use.



FOREIGN PARTICLES

- Dust

Dust from the normal "breathing" of the engine causes grit to be carried into the lubricating system. If your vehicle is subject to dusty operation, pay attention to the warning contained in your operator's manual and change the oil and filter more frequently.



- Metal Particles

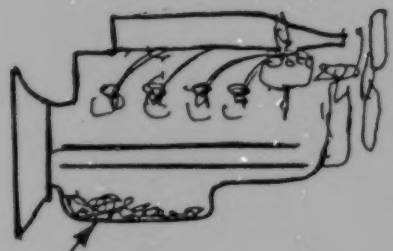
Metal particles from normal engine wear will be carried by the oil throughout the engine.

FUEL SOOT

Oil is thickened by the soot from unburned fuel that is washed into the oil supply.

WATER

Over a gallon of water vapor is formed as each gallon of fuel burns. Much of this water gets into the crankcase. Normally, the engine heat of 145° and over will evaporate the water from the oil. Eight times as much engine wear is caused at 100° as opposed to 160° operating temperature. Water not only attacks exhaust systems but may freeze in the oil or cause "cold temperature sludge". Sludge can plug oil lines, screens, piston rings, etc. There are ways to avoid these problems:



Sludge builds inside an engine that is not properly warmed up.

1. Warm up your engine before applying a load.
2. Be sure engine is thoroughly warmed up each time it is used.
3. Use proper thermostats.
4. Check temperature frequently.
5. Drain oil when engine is hot.

ANTI-FREEZE

Anti-freeze may enter the crankcase anytime a head gasket leaks or a valve seat cracks. Anti-freeze in the oil is detectible by bubbles in the radiator and a foaming in the crankcase (foam bubbles are detectible on the oil dip stick).

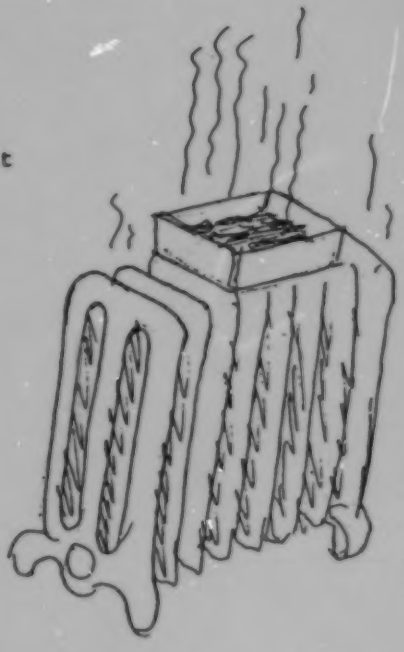
Anti-freeze contamination will neutralize many of the oil additives, from sludge and oil varnish. Prolonged running of the engine with anti-freeze contamination will probably result in the need for a complete engine overhaul.

FUEL

Fuel may be pumped into the oil crankcase by a cracked diaphram on the fuel pump or a bad seal in the fuel injection pump. Carburetor flooding, overchoking, engine missing, and cold engine operation, while not so dramatic as a cracked diaphram or seal, will also put fuel into the crankcase.

The protective coat of oil on the cylinder walls and other parts will be washed off, exposing the engine to metal-to-metal contact and wear, oil in the crankcase will be diluted, many additives will no longer function, and oil sludge and engine varnish will result. Continued operation with this condition will cause major engine breakdown. Some good rules to follow to prevent this condition are:

1. Don't overchoke
2. Fix flooding carburetor
3. Avoid excessive idling
4. Bring engine up to heat each time you use it
5. Buy clean-burning fuel



OVERHEATING ENGINE OIL

Be sure your engine is properly tuned, the radiator is clean and bug free, and you are using proper fuel.

An engine that runs hot will shorten the life of the oil. The engine may overheat as a result of poor cooling or conditions that cause more heat than the cooling system was designed to handle, such as bad timing, pre-ignition, detonation, etc.

Each 20°F (approximate) increase over 185° will double the oxidation rate of the oil. Oxidized oil will cause sludge and, perhaps, stuck rings and valve lifters. Avoid and overheated engine.

NOTE: If oil is "cooked" long enough, it will turn into tar. Be careful to prevent that from happening to your vehicle!

CHART #1

A new scale was developed in general terms as follows:

SERVICE CLASS	USE	SPECIFICIATIONS MET	CURRENT USE
ML	gasoline, light service		Discontinued in 1969
MM	gasoline, moderate service	Mil L - 2104A Mil L - 2104B	Discontinued in 1971
MS	gasoline, special lubrication requirements	Auto Manufacturers	Discontinued in 1971
DG	diesel, light service		Discontinued in 1971
DM	diesel, moderate service	Mil L - 2104B	Discontinued in 1971
DS	Diesel, servere service	Mil L - 45199B Caterpiller Series 3	

CHART #2

SAE LETTER DESIGNATION	API IDENTIFICATION AND ENGINE SERVICE DESCRIPTION	ASTM OIL DESCRIPTION
SA	Gasoline & diesel engines, light conditions	No oil additives required
SB	Gasoline engine, minimum duty	Provides some anti-scuff & anti-oxident additives
SC	Gasoline engine, to meet 1964 to 1967 auto manufacturer's warranty requirements	Intended for passenger cars, adds low temperature sludge inhibitor and anti-rust performance
SD	Gasoline engine, to meet 1968 auto manufacturer's warranty standards	Intended for passenger cars, adds low temperature sludge inhibitor and anti-rust performance
SE	Gasoline engine to meet 1972 auto manufacturer's warranty standards	Intended for passenger cars, adds low temperature sludge inhibitor & anti-rust performance
CA	Diesel engine, light duty, high quality fuels	Oils meeting the 1954 Mil Spec L 2104A
CB	Diesel engine, moderate duty or light duty with lower quality fuels. Needs bearing and high temperature deposit control.	Oils meeting Mil Spec L 2104A where tested using high sulphur fuel
CC	Gasoline & Diesel engines, moderate to severe duty. Protects from high temperature deposits, low temperature sludge and rust	Oils meeting Mil Spec L - 2104C
CD	Diesel engines in severe duty. Highly supercharged, high speed, high output. To be used to control damage as above plus used in engines accepting a wide range in quality of fuel	Oils that meet the following: Mil Spec L - 45199B Caterpiller Series 3

CHART #3

APPLICATION	API CLASSIFICATION EFFECTIVE 1971	API RATING 1970 & EARLIER	COMMENTS
Gas engine (spark)	SD	68 MS	Meets manufacturer's 1968 warranty requirements
Passenger car	SE		SE meets 1972 warranty requirements
Gas engine (spark)	CC	Mil L - 2104B	Heavy duty application meets low temperature requirements
Truck or bus	SE		SE meets 1972 warranty requirements
Diesel engine Truck and bus	CB CC CD	Supp 1 Mil - L 2104B Series 3	Involves engine design in addition to severity of service. See manufacturer's recommendations
Diesel engine off-highway	CB CC CD	Supp 1 Mil L - 2104B Series 3	Involves engine design in addition to severity of service. See manufacturer's recommendations

Severe operating conditions include:

- frequent start and stop operation

- prolonged idling

- cold weather, light loads

- hot weather, heavy loads

In operating diesel, the same applies plus the problem of deposits generated when using fuel of more than 0.5% sulphur content.

WORKSHEET

STUDENT ACTIVITY

Change the oil and oil filter on a car, truck or tractor. The following procedure may be used if the trainee is unfamiliar with oil changing.

1. Always change the oil when engine is at operating temperature. The heated oil flows readily and the suspended sludge particles will drain out with the oil.

2. Raise vehicle (if necessary) to provide adequate clearance to engine bottom for removal of oil, the plug and placement of the drain oil container. CAUTION: Always use safety jacks if floor jack is used to raise vehicle. BE SURE vehicle cannot fall.

3. Locate oil drain plug on the engine crankcase. (Be sure you have the engine drain plug.)

4. Using a box end wrench or a large crescent wrench, remove drain plug and catch oil in the drain oil container.

   NOTE: Never use a pipe wrench or vise grip pliers. They may ruin the oil plug.

5. Allow oil to drain completely, then clean and replace drain plug. Tighten snugly.

6. If oil filter is accessible from beneath the vehicle, it should be replaced while vehicle is raised. Normally, this will be a cartridge or "spin-on" type of filter. A wrench is usually required to remove the cartridge. CAUTION: The oil cartridge is also filled with hot oil. Sometimes it is mounted at an angle and oil will spill out. Remove the cartridge swiftly and place where it can drain.

7. If it is a cartridge spin-on filter:

   a) clean the filter base (on the engine) clean
   b) put a thin coat of oil on the filter gasket
   c) spin the cartridge on its mounting until contact is made
   d) tighten about half a turn more
   e) go to step #9

8. If the filter is of the disposable element type, usually mounted in the engine compartment:

   a) remove and discard the filter element
   b) remove the excess oil from
   c) wipe the filter housing thoroughly with a clean rag
   d) insert new element
   e) remove old gasket from the cover, replace with new one and give it a thin coat of oil.
   f) tighten cover securely

9. Lower vehicle, replenish with oil that meets vehicle manufacturer's specifications for the intended use of the vehicle. If filter has been replaced, add the proper amount of extra oil.

   NOTE: Use care to assure that all of the oil goes into the engine. Oil spilled on the engine rots rubber belts and hoses. It also causes oil fumes in the car, and attracts dust causing a very untidy engine compartment. This not only irritates customers, it makes further maintenance work a disagreeable task.

10. Before starting engine:

    - replace oil filter cap
    - check the oil to assure proper level

    NOTE: Checking the oil is a double check that the crankcase drain plug has been replaced. (Insert dipstick and press it fully down until the cap seats. Then remove and read.)

11. Start engine, bring up the oil pressure and run at fast idle for at least sixty seconds.

    - check under car to assure that the drain plug is not leaking
    - check around oil filter to assure no leakage there

12. Stop engine and re-check oil level. It should be near, but not over, the full mark. (If oil is above the add line, it will not accept a full quart of oil.)

SELF TEST

1. How does oxidation and corrosion inhibitors protect bearing surfaces?

2. Detergents act like soap to keep particles _____ in the oil.

3. The lower the viscosity number, the _____ the oil.

4. Given 10W - 30 oil, what number applies at 0°?

5. Every time a motor is started, it should be brought up to _____.

6. _____ specify oil requirements for every engine.

7. List four severe operating condition for engines.

SELF-TEST ANSWERS

1. forms a film to keep acids away
2. suspended or floating
3. thinner
4. 10W
5. normal operating temperature
6. manufacturers
7. frequent start/stop.
   long idling periods.
   cold weather, light loads.
   hot weather, heavy loads.

POST-TEST KEY Package No. 108-B

OIL STANDARD LUBRICATION AND SELECTION

1. How readily an oil flows.

2. An additive that lowers the amount of foam in the oil.

3. Detergent oils - those oils that have an additive added (soap) to keep dirt and sludge particles suspended and floating in the oil.

4. Society of Automotive Engineers.

5. a. SAE 30w
   b. SAE 20w
   c. SAE 10w
   d. SAE 5w

POST–TEST

Package Number 108-B

OIL STANDARDS AND LUBRICATION

Name _____ Date _____

1. Define Viscosity.

2. What is an anti-foam agent?

3. What are detergent oils?

4. What does the initials S.A.E. stand for?

5. Given these temperatures what is the recommended oil to use?

	Single Viscosity Grade
Above 90° F	A
32° F - 90°F	B
-10° F - 32° F	C
Below 10° F	D